the next instrument; and so on through the series. Instead of sending down a messenger on the wire, a propeller-wheel has also been arranged to open the jaws, so that either method may be employed.

The question arises, whether, with these excellent methods of using the instrument, the Negretti and Zambra thermometer cannot be made to record accurately to tenths of a degree. It would seem, that, by giving it a short range and a comparatively long tube,

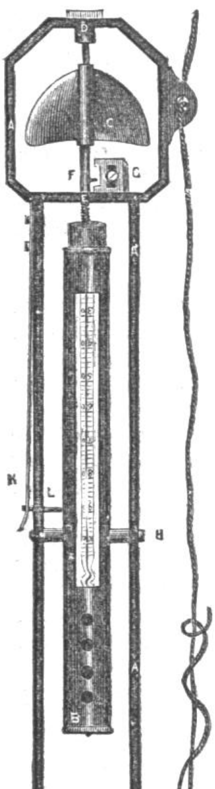

FIG. 2.

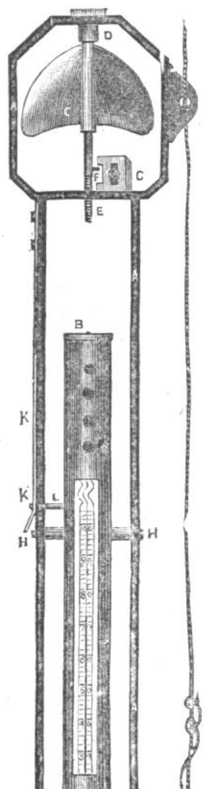

FIG. 3.

this might be done. If not, the most delicate observations for sub-surface temperatures will probably have to be made with some form of apparatus, which, like that used by Professor Ekman, brings the water to the surface in a case covered with a material through which heat cannot readily pass, or else by sending down a thermometer enclosed, like Capt. Rung's, in a thick case of non-conducting material. R. HITCHCOCK.

London, June 1, 1883.

REAL ROOTS OF CUBICS.

THEOREM I.

[IN the equation $x^3 + Ax^2 + B = 0$, when the roots are real, A and B have opposite signs; and simultaneously changing the signs of A and B changes signs of roots of equation.]

Assume $x = a$, $x = b$, $x = -\frac{ab}{a+b}$.

$$x^3 - \frac{1}{a+b}(a^2+ab+b^2)x^2 + \frac{1}{a+b}(a^2b^2) = 0; \quad (1)$$

and, changing signs of roots,

$$x^3 + \frac{1}{a+b}(a^2+ab+b^2)x^2 - \frac{1}{a+b}(a^2b^2) = 0. \quad (2)$$

Since the factors (a^2+ab+b^2) and (a^2b^2) are positive when the roots are real, whatever the sign of $\frac{1}{a+b}$, A and B will have opposite signs, and, from (1) and (2), simultaneously changing signs of A and B changes signs of roots of equation.

THEOREM II.

$\left[\frac{A^3}{27}\right.$ is greater than $\frac{B}{4}$ in quantity.$\left.\right]$

$$\text{Assume} \quad \left(\frac{a^2+ab+b^2}{3(a+b)}\right)^3 > \frac{a^2b^2}{4(a+b)} \quad (3)$$

$$\text{or} \quad \left(\frac{a^2+ab+b^2}{3}\right)^3 > a^2b^2\left(\frac{a+b}{2}\right)^2;$$

$$\text{but} \quad \left(\frac{a+b}{2}\right)^2 \geqq ab \quad \text{(Algebra)}:$$

hence inequality (3) is true.

From (1), omitting the term $\frac{A}{3}$,

$$\frac{x}{\left(-\frac{B}{4}+\frac{A^3}{27}\right)^{\frac{1}{3}}} = \left(1 + \frac{\sqrt{\frac{B}{4}}}{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}\sqrt{-1}\right)^{\frac{2}{3}} + \left(1 - \frac{\sqrt{\frac{B}{4}}}{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}\sqrt{-1}\right)^{\frac{2}{3}}; \quad (4)$$

and, from (2),

$$\frac{x}{\left(\frac{B}{4}\right)^{\frac{1}{3}}} = \left(1 + \frac{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}{\sqrt{\frac{B}{4}}}\sqrt{-1}\right)^{\frac{2}{3}} + \left(1 - \frac{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}{\sqrt{\frac{B}{4}}}\sqrt{-1}\right)^{\frac{2}{3}}. \quad (5)$$

In (4) the coefficient of $\sqrt{-1}$ may have any magnitude, and in (5) the coefficient of $\sqrt{-1}$ is the reciprocal of that magnitude. And since from any cubic (Theorem I.) (4) or (5) may be obtained, it follows, that, when the real part is unity, the coefficient of $\sqrt{-1}$ may be made less than unity, and real (Theorem II.).

Put n = coefficient of $\sqrt{-1}$, we have, by expansion,

$$(1+n)^{\frac{2}{3}} + (1-n)^{\frac{2}{3}} = 2-4\left(\frac{1}{3 \, . \, 6}\right)n^2 - 4\left(\frac{4 \, . \, 7}{3 \, . \, 6 \, . \, 9 \, . \, 12}\right)n^4 - 4\left(\frac{4 \, . \, 7 \, . \, 10 \, . \, 13}{3 \, . \, 6 \, . \, 9 \, . \, 12 \, . \, 15 \, . \, 18}\right)n^6, \text{ etc.}$$

The series, already converging, is made doubly converging by the high powers of n, since n has been made a fraction. Putting n, for example, no smaller than $\frac{1}{10}$, the correction for the sum of the series at the eighth term would be less than $\frac{1}{1{,}400{,}000{,}000{,}000{,}000{,}000}$. And, as the precision of the value of x is determined proportionally to the accuracy with which the series is summed, it follows that a good approximation to x may be obtained by using a very few first terms of the series.

A. M. SAWIN.

THE HABITS OF MURAENOPSIS TRIDACTYLUS IN CAPTIVITY; WITH OBSERVATIONS ON ITS ANATOMY.

THE Louisianian district of the Austroriparian region is a particularly rich field for the herpetologist. Thirty-six species of reptiles are known to be confined to its limits alone, not to mention a long list of others that range generally over the southern states; and to these we must add those species which are mentioned by the old French authors, but have not yet been taken by American naturalists, a knowledge of which fact always enhances the interest of a country in the eyes of the explorer, who pushes his way through its tangled jungles, or visits its unfrequented spots and its sultry forests, for the first time.

After my arrival in New Orleans, the months that are included in the pseudo-winter of this sub-tropical land came and passed by, before my collection could boast of a single specimen representing the Amphiumida: indeed, it was not until April had almost made its appearance that a superannuated old negro presented himself one morning with a live but rather small specimen of the three-toed siren, the subject of this essay.

He called it a 'Congo eel,' — a name which is indifferently applied by every one here, intelligent as well as ignorant, to both this reptile and Amphiuma means. Long before this, reports had come to me from far and near of the dreaded 'Congo,' or 'lamprey' as it is often called. It was universally said that its bite was invariably fatal. To such an extent was this believed, that, I am told, a physician of the city, of undoubted reputation in his profession, and a capital chemist, but possessing nothing more than a general knowledge of natural science, was actually making experiments with the view of examining the venom of this innocent amphibian. When my aims became pretty thoroughly known throughout my section of the country, I applied a very different kind of analysis to this problem: a good round sum of money was offered to any one who would bring me the full record of a well authenticated case of death from the bite of the Congo snake, or eel. It is almost needless to add, that I never had to pay the reward. One person, more mercenary than well informed in such matters, did bring forward a case of an hysterical old colored woman who had been bitten several years ago by a Congo eel, and died *six months* after the infliction of the wound, in spasms!

The small one, which now came into my possession, was placed in water, in a large comfortable vessel, for observations upon his habits, before he was finally consigned to his tank of alcohol. In handling him, he rarely

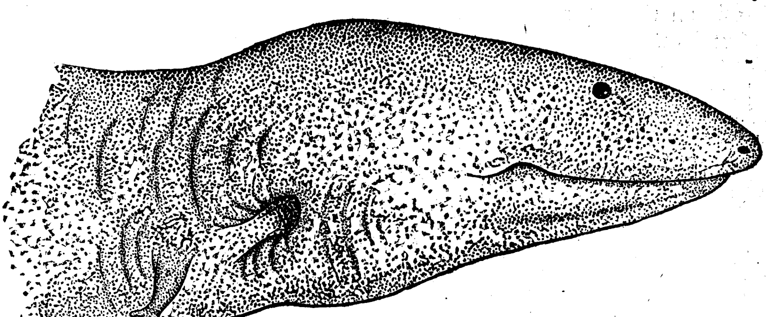

FIG. 1. — Life-size head of Muraenopsis tridactylus; adult. Drawn from the living specimen by the author.